ISSN:2320-0790

An International Journal of Advanced Computer Technology

Low Control Overhead for Cluster Maintenance in Wireless Network for DSR Protocol

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Abstract- Wireless networks are getting popular due to their ease of use. Mobile Ad Hoc network (MANET) has become an exciting and important technology in recent years because of the rapidly increases of wireless devices. Mobile Ad-hoc Networks are distributed systems consisting of mobile nods that are connected by multi-hop wireless links. Such system is self-organized and facilitates communication in the network without any centralized infrastructure. In MANET mobile nodes are battery operated and they are free to move in any direction, so routing strategies may be changed frequently. Thus, Mobile nodes' battery and mobility are important parameters in MANET. Clustering in MANET has evolved as an imperative research domain that enhances system performance such as throughput, delay and it increases system capacity in MANET in the presence of mobility and large number of mobile terminals.

In Clustering, mobile nodes in MANET are divides into different virtual groups. Election of cluster head is very much important in clustering. It effects on cluster stability and life-time. Our proposed algorithm considers Energy and Mobility parameters for election of cluster head. By selecting most suitable node as cluster head we can increases efficiency of cluster. We have implemented proposed algorithm in ns-2.33 simulator.

Keywords—MANET, AODV, Clustering, Cluster Head, Gateway, PDF

I. INTRODUCTION

Wireless technologies is very popular and it takes an important place in day-to-day life, which have ubiquitous features, satisfying the demand of the network communication each and every place, and it can be perform at any time. There are different kinds of portable devices like laptop computers, personal digital assistance (PDA) and mobile phones which are Ad-hoc Network and create an infrastructure less Environment. Therefore it will helpful for accessing a static network or dynamic network to support their mobile device services. So providing better solution for network MANET is emerged. Mobile Ad-hoc Network (MANET) is a self-configuring infrastructure less network, that consisting of mobile nodes which are connected by multi-hop wireless links. In MANET, networks are formed on the fly and devices can leave and join the network during its lifetime [1]. In mobile ad hoc network (MANET) mobile nodes are move randomly and they stable by themselves arbitrarily, so the topology of wireless network may be changed frequently, thus There is no uniform infrastructure; for instance. Since routing is an important strategy, which make node as a router for forwarding data packets and make proper communication to their neighbouring node. All nodes can easily move and can be connected dynamically in an arbitrary manner. In this kind of networks node have heterogeneity, so some pairs of nodes may not be able to communicate directly with each other and have to rely on some other terminals so that the messages are delivered to their destinations [2]. This type of network is known as multi-hop networks. In MANET, nodes are connected together by wireless network with infrastructure less environment. Due to the advancement in mobile devices and handsets, the need of 802.11\WI-Fi wireless networking is rapidly increase [1]. Hence MANET is an important topic for research area. In routing, strategies for routing may change frequently so the control overhead of the routing is drastically increased. So decreasing that control overhead on routing we have to understand the concept of cluster, thus clustering is an essential research topic for Mobile Ad Hoc networks (MANETs).Cluster is nothing but it is the virtual group of nodes, and divides the whole network into virtual group. Clustering makes possible a hierarchical routing in which paths are recorded between cluster instead of between nodes, thus it will increase the routes lifetimes, and decrease the amount of routing control overhead [3].

A Mobile Ad-Hoc Network is a combination of self-configuring infrastructure less network, that contain different mobile devices which are connected by wireless links forming an arbitrary topology, where:

- Each mobile devices in MANET is free to move in any direction independently and organize themselves arbitrarily, it may frequently link with other devices [1].
- The network's wireless topology may change rapidly and unpredictably, thus routing strategies may frequently change.

Such a network may operate in a standalone method, or a part of a larger network (i.e., internet).

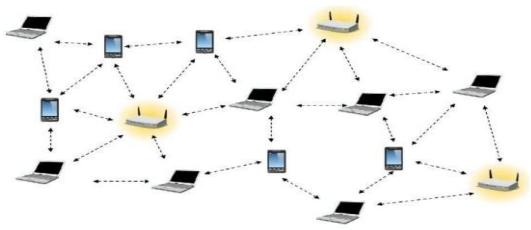


Figure 1: MANET [19]

A Mobile Ad hoc Network as shown in Fig.1is a wireless ad

hoc network, and is a self- configuring network of mobile devices are connected by wireless links [2]. That devices are act as a router they are free to move in any direction and organize themselves arbitrarily; thus, the network's wireless topology and routing strategies may change rapidly and unpredictably. Such a network may works in a standalone fashion, or may be connected to the larger Internet.

In MANETs the nodes communicate with each other over reliable wireless links. All nodes within the transmission range. If two nodes which are not belong to the transmission range and if they want to communicate with each other, then they have to rely on the intermediate nodes for forwarding data packets from one node to another node. There are different strategies for routing which is use for transferring data packet to nodes they have some merits and demerits that discusses further. So, many clustering techniques have been proposed where the nodes in the network are divides into the clusters.

In Clustering, the mobile nodes in a network are divided into distinct virtual groups and create sub network. Clustering is control based routing in that there is cluster head that manage or maintain the whole cluster; it has ability in performing the role of the local coordinator. The MANET Clustering problem is to partition M into a set of Clusters, C = {c1, c2, c3...cn} such that c1 ∪ c2 ∪...∪cn= M.

The Cluster based network introduces three types of nodes in MANET:

1. Cluster Head:

Cluster Head serves as a leader node for its Cluster. It performs communication among various mobile nodes in a cluster. It performs inter cluster transmission; data forwarding and so on.

2. Cluster Gateway:

It is a non Cluster Head node. It is also called as Border node in Cluster. It is responsible for communication among neighbouring clusters.

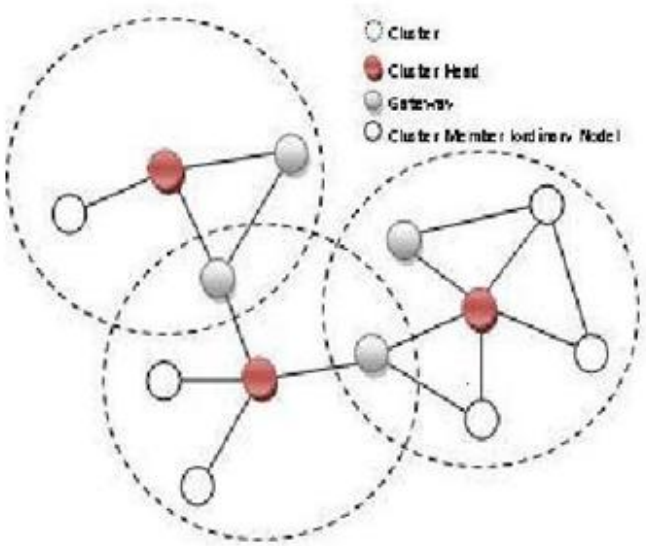


Figure 2: Clustering in MANET [4]

3. Cluster Member:

It is also called as Ordinary nodes in the Cluster. It is neither Cluster Head node nor Border nodes.

In any clustering scheme there are two main phases have to discuss.

1. Cluster formation . 2. Cluster maintenance phase.

Regarding to clustering concepts in MANET, in cluster formation, one node must be elected as a special node called Cluster Head (CH) which provides virtual infrastructure for particular cluster. Hence, remaining nodes will be referred as Ordinary Nodes (CN) except Cluster Gateways (CG) which are the nodes that act as shared nodes between more than cluster. In cluster maintenance reduces the cluster overhead of routing information and make cluster stable as well as efficient. According to the way of grouping nodes within clusters, several techniques have been proposed. All of these agreed that the clustering formation and maintenance phases are very important concepts in power consumption enhancement for MANETs.

Advantages of Clustering in MANETs:

1. It increases system capacity by spatial reusing available resources and spatial reuse of wireless bandwidth. If two clusters are not neighbouring clusters and they are not overlapped then they can use same set of frequency [12].

2. Cluster Head and Border nodes form a virtual backbone for routing among neighbouring clusters. So generation and spreading of routing information is minimized to this set of nodes [20, 21].

3. Resource allocation can be done in efficient manner among mobile nodes [20, 21].

4. The flexible response to topology changes by node movement [12].

5. In Cluster when mobile node moves to another cluster, only nodes present at that cluster need to update the information. So information stored by each node is reduced, thus overhead of storing information is decrees.

6. Cluster can better coordinate its transmission events with the help of the special mobile node, Cluster Head, residing in it. This can save much resources used for retransmission resulting from reduced transmission collisions.[22]

7. The reduction of control packets in routing [12].

Disadvantages of Clustering in MANETs:

1. To maintain the cluster structure in a dynamically changing environment often requires explicit message exchange between mobile nodes. When the underlying network topology changes quickly and involves many mobile nodes, the clustering-related information exchange increases drastically. Frequent information exchange may consume considerable bandwidth and drain mobile nodes' energy quickly [20].

2. If cluster head 'die' due to affecting parameter like energy, mobility, collision, attacks, thus we have to re-election for cluster head. This is also called as ripple effect of re-clustering.

The rest of this paper is organized as follows. In section 2, we briefly describe AODV routing protocol. Section 3 presents the related work in literature review, Section 4 discusses about our proposed algorithm for Clustering, Section 5 discusses about

experimental result. We conclude in section 6 with future work.

II. AN OVERVIEW OF AODV ROUTING PROTOCOL

Dynamic Source Routing (DSR) [3] is a reactive protocol i.e. it doesn't use periodic advertisements. It computes the routes when necessary and then maintains them. Source routing is a routing technique in which the sender of a packet determines the complete sequence of nodes through which the packet has to pass; the sender explicitly lists this route in the packet's header, identifying each forwarding "hop" by the address of the next node to which to transmit the packet on its way to the destination host.

There are two significant stages in working of DSR: Route Discovery and Route Maintenance. A host initiating a route discovery broadcasts a *route request* packet which may be received by those hosts within wireless transmission range of it. The route request packet identifies the host, referred to as the *target* of the route discovery, for which the route is requested. If the route discovery is successful the initiating host receives a *route reply* packet listing a sequence of network hops through which it may reach the target. In addition to the address of the original initiator of the request and the target of the request, each route request packet contains a *route recor*d, in which is accumulated a record of the sequence of hops taken by the route request packet as it is propagated through the network during this route discovery.

While a host is using any source route, it monitors the continued correct operation of that route. This monitoring of the correct operation of a route in use is called *route maintenanc*e. When route maintenance detects a problem with a route in use, route discovery may be used again to discover a new, correct route to the destination.

To optimize route discovery process, DSR uses cache memory efficiently. Suppose a host receives a route request packet for which it is not the target and is not already listed in the route record in the packet, and for which the pair (initiator address, request id) is not found in its list of recently seen requests; if the host has a route cache entry for the target of the request, it may append this cached route to the accumulated route record in the packet, and may return this route in a route reply packet to the initiator without propagating (re-broadcasting) the route request. The delay for route discovery and the total number of packets transmitted can be reduced by allowing data to be piggybacked on route request packets.

III. LITERATURE SURVEY

We have reviewed various clustering algorithms. Each algorithm considers different parameters for election of Cluster Head node. Election of Cluster Head is difficult in Clustering. We present each algorithm with its advantages and drawbacks in tabular form. Algorithms like Lowest ID, Highest degree connectivity, K-hop connectivity, MOBIC, LCC, WCA etc are studied from various research papers.

Table 1: Comparative analysis of Clustering algorithms

Clustering Scheme	Cluster Head Selection Criteria	Benefits	Drawbacks
Lowest ID	Node with minimum id which is distinct	Simple to implement	1.Certain nodes are prone to power drainage due to serving as CH for longer time 2.Generates more CH than necessary
Highest Degree	Node with highest connectivity value among its neighbors.	Less hop to fulfill a request.	1. Due to high mobility frequent change of topology occurs. Hence Congestion in Cluster head and erratic exchange of CH occurs. (2)Numerous ties between nodes. (3)Only one hop connectivity.
Max Min d cluster	(1)Node participates in CH selection based on their node id. (2)Once the CH is selected sender node determines the shortest path.	(1)Less number of CHs and hence less traffic. (2)Operates asynchronously. (3)No. of messages sent from each node is limited to a multiple of d rather than „n".	(1)How to select value of d is not specified. (2) Number of members increased in a cluster So, CH drains rapidly.
K-hop connectivity	Node with higher connectivity is chosen as CH, in case of tie ID is considered to select CH. Each node	(1)Obtain minimum no. of clusters and smaller size of dominating set.	(1)Number of nodes will be increased in a cluster so CH will drain rapidly.

	has 2 tuples (d,ID) d: degree		
Adaptive cluster load balancing	(1)Hello Message format is used which has an item „options". a.If sender node is CH it will assign „options" to no. of dominating members else it will be reset to 0. b. If hello message of CH shows its dominating set is greater than threshold (max. no. one CH can manage) no new node will participate in that cluster.	(1) Cluster head (CH) bottleneck phenomenon is eliminated and cluster structure is optimized. (2) Load balance between various clusters is implemented. (3) Resource consumption and information transmission is distributed uniformly among all clusters.	Can not eliminate the tie between same nodes having same cardinality
MOBIC	Mobility (computed over a small time period by calculating the variance of relative mobility between a node and all its neighbor)	Re-affiliation count is decreased	In case of particular scenarios where the relative mobility between nodes does not differ drastically, the mobility metric gives better results.
MobDHop	Relative mobility of two	(1) Minimizes the	Only mobility metric is taken into

	nodes (variation of distance between nodes over time)	number of clusters by considering group mobility pattern (2)Makes cluster more stable	considerate-on.
LCC	Node ID	LCC significantly improves Cluster stability by releasing the requirements that a Cluster Head should always have some specific attributes in its local area.	If single node moves outside the assigned Cluster; it may be require complete Cluster structure re-computation
LBC	Energy level	(1) The newly chosen mobile node would be having good Energy level. So, no CH bottleneck (2) And its previous total cluster head serving time is the shortest in its neighbour-hood.	Cluster head serving time can not be good indicator for energy consumptionof a mobile node.
WCA	Node degree, Distance	(1)To avoid Communic	(1)Knowing the weights of all the nodes before

	summation to all its neighbouring nodes, Mobility , Remaining battery power	ation overhead, this algorithm is not periodic and the Cluster head Election procedure is only invoked based on node mobility and when the current dominant set is incapable to cover all the nodes. (2) To ensure That cluster heads will not be over-loaded, a pre-defined threshold is used	starting the clustering process (2)Drains the CHs rapidly.

IV. Proposed Algorithm For Clustering

In a Clustering schema the mobile nodes in a MANET are divided into different groups. Clustering is separated into two phases.

1. Cluster Formation
2. Cluster Maintenance

// Algorithm for Cluster Formation:

Step 1: Deploy the nodes in the Network. We have select 20 nodes, 30 nodes, 40 nodes and 50 nodes.

Step 2: Determine each nodes' position and energy.

Econsumed = Energy required for performing each operation * number of packets participate in each operation;

$E_{Remaining} = E_{Total} - E_{Consumed}$.

Calculation for Mobility:

$$D_t = \sum_{j=1}^{n} dist_{(i,j)} \quad (3)$$

$$dist_{(i,j)} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \quad (4)$$

$$M_i = \frac{1}{\Delta t} |D_i(t) - D_i(t + \Delta t)| \quad (5)$$

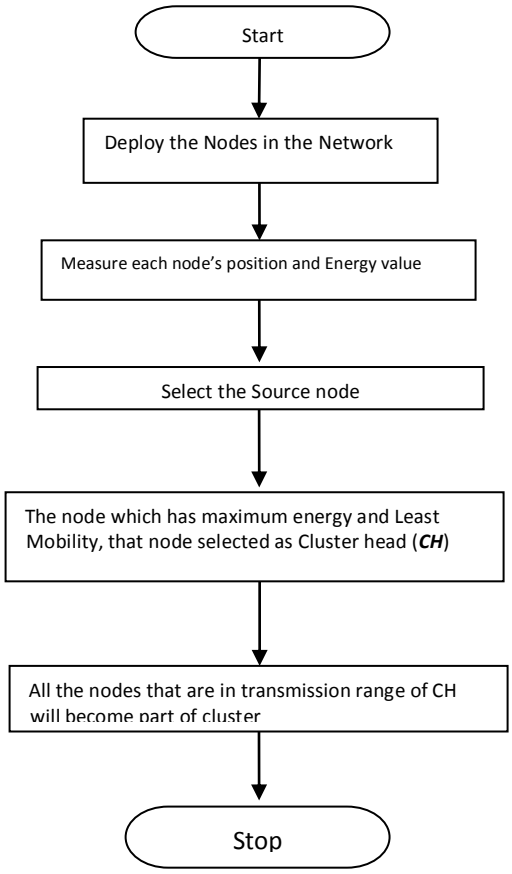
$$D_i(t) = \frac{1}{n} \sum_{j=1}^{n} dist_{(i,j)}(t) \quad (6)$$

Step 3: Search the node having maximum energy and least mobility which will act as a cluster head

Step 4: Make all the neighboring nodes of Cluster Head as a part of cluster.

Step 5: Stop.

// Flowchart for Cluster Formation:



V. EXPERIMENTAL RESULT

Table 2: Simulation Parameters Table

Parameter	Value
Number of nodes	20,30,40,50
Simulation time	150 sec
Environment size	1000x1000
Transmission range	30 m
Traffic type	TCP
Packet size	512 bytes
Maximum speed	20 m/s
Queue length	50
Simulator	Ns-2.33
Antenna type	Omni directional

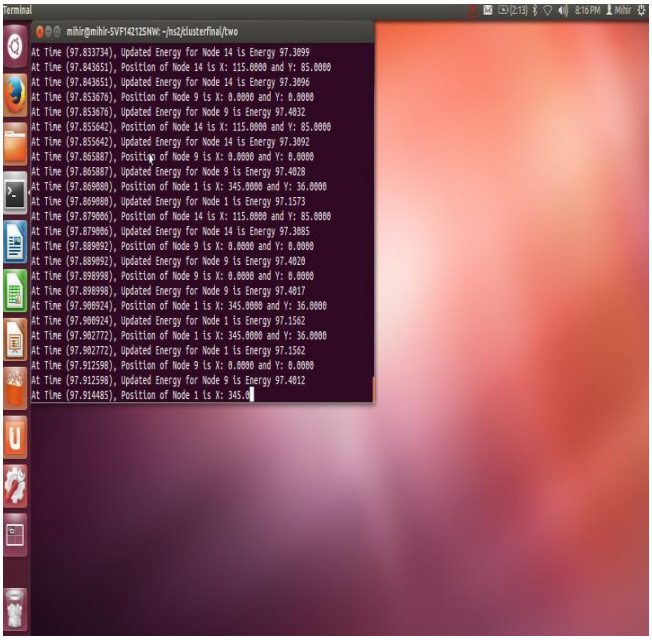


Figure 4: A Screenshot for calculation of co-ordinate position and energy

Above figure shows screen shot for calculating co-ordinate position and energy of each node. From it we can find all nodes which are nearer to CH in one Cluster. Next figure shows screen shot for cluster20.nam file at time=10 ms for two Clusters. In Clustering will be done through the cluster head.

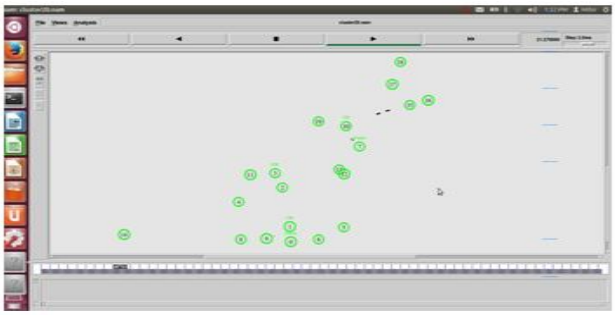


Figure 5 : A Screenshot for Clustering_2 for twenty nodes at middle stage

Table 3: comparison of PDF of normal AODV, AODV with two Clustering

Nodes	Normal AODV	AODV With two Clustering
20	96.53	97.02
30	97.14	97.4
40	97.3	98.44
50	97.5	98.77

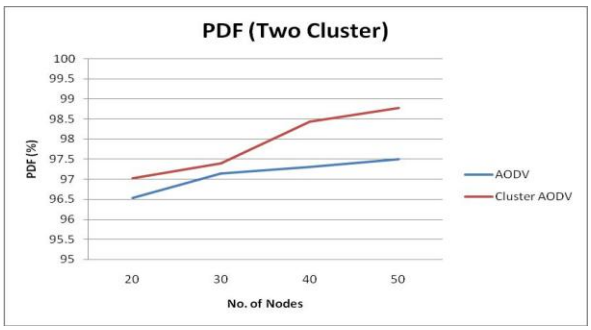


Figure 6: No. of nodes Vs. PDF for two Clusters

Table 4: comparison of PDF of normal AODV, AODV with two Clustering

Nodes	Normal AODV	AODV With three Clustering
20	96.53	99.74
30	97.14	99.49
40	97.3	99.52
50	97.5	98.77

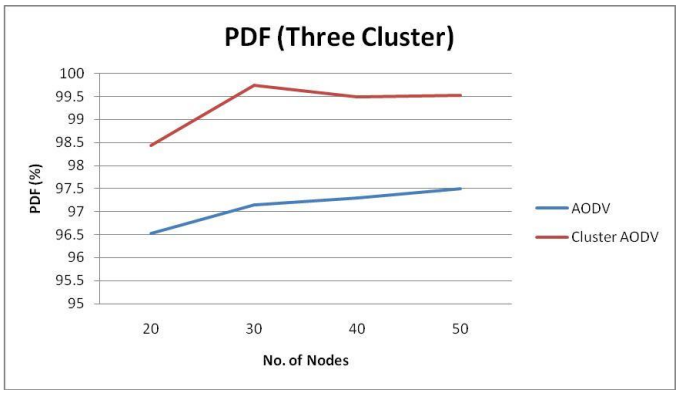


Figure 7: No. of nodes Vs. PDF for three Clusters

Table 5: Comparison of PDF AODV with two Clusters, AODV with three Clusters

Nodes	AODV with two Clustering	AODV With three Clustering
20	97.02	99.74
30	97.4	99.49
40	98.44	99.52
50	98.77	98.77

From above results, we can conclude that with the help of Clustering in MANET Packet Delivery Fraction (PDF) increases compare to Normal AODV routing protocol. Following table shows comparison of PDF for two Clusters in AODV Vs. three Clusters in AODV. By increasing number of Clusters in the network of nodes, PDF also increases.

Packet delivery ratio: the ratio of the number of delivered data packet to the destination. This illustrates the level of delivered data to the destination.

PDR = ∑ Number of packet receive / ∑ Number of packet send.

VI. CONCLUSION

Mobile Ad Hoc Networks are self-organized networks whose nodes are free to move randomly. Mobile nodes can communicate with each other without the help of the existing network infrastructure. Clustering is an important research topic for mobile ad hoc networks (MANETs). In a Clustering scheme the mobile nodes in a MANET are divided into different virtual groups. In this report, we have provided fundamental concepts about clustering, including definition of clustering. Then we presented related research which has already done in clustering topic in MANET. We have also presented comparative analysis of some existing clustering algorithms with its pros and cons. Then we presented proposed algorithm and methodology for cluster formation and maintenance. In that, Cluster formation phase, node which has Maximum Energy and Least Mobility will be elected as Cluster Head. And all nodes which are nearer to Cluster Head will become part of that Cluster. So Cluster will be formed. Here, we are representing Dynamic Cluster. Our goal is to keep cluster head changes as least as possible to make cluster structure more efficient.

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